

#469

HELIOS A + B
LOG ANT TEMP VS TIME

74-097A-06B
76-003A-06B

HELIOS-A

LOG ANT TEMP VS TIME ON TAPE

74-097A-06B

This data set has been restored. There was originally one 9-track, 1600 BPI tape written in Binary. There is one restored tape. The DR tape is a 3480 cartridge and the DS tape is 9-track, 6250 BPI. The original tape was created on a 360 computer and the restored tape was created on an IBM 9021 computer. The DR and DS numbers along with the corresponding D number are as follows:

<u>DR#</u>	<u>DS#</u>	<u>D#</u>	<u>FILES</u>	<u>TIME SPAN</u>
DR004795	DS004795	D040296	1	12/31/74 - 04/25/76

HELIOS-B

LOG ANT TEMP VS TIME

76-003A-06B

THIS DATA SET HAS BEEN RESTORED. ORIGINALLY IT CONTAINED ONE 9-TRACK, 6250 BPI TAPE WRITTEN IN BINARY. THERE IS ONE RESTORED TAPE. THE DR TAPE IS A 3480 CARTRIDGE AND THE DS TAPE IS 9-TRACK, 6250 BPI. THE ORIGINAL TAPE WAS CREATED ON AN IBM 360 COMPUTER AND WAS RESTORED ON AN IBM 9021 COMPUTER. THE DR AND DS NUMBER ALONG WITH THE CORRESPONDING D NUMBER IS AS FOLLOWS:

DR#	DS#	D#	FILES	TIME SPAN
DR004840	DS004840	D040297	1	02/02/76 - 10/31/77

REQ. AGENT
DEW

RAND NO.

ACQ. AGENT
HKH

HELIOS A+B

LOG ANT TEMP VS TIME

74-097A-06B + 76-003A-06B

These data sets consists of 2 tapes one for each ID. They are 6250 BPI, 9 track, Binary with one file of data. They were created on an IBM 360 computer.

74-097A-06B

<u>D#</u>	<u>C#</u>	<u>TIME SPAN</u>
D-40296	C-21068	12/13/74 - 4/25/76

76-003A-06B

D-40297	C-21069	2/02/76 - 10/31/77
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HELIOS EXP SC

SUMMARY TAPE

Table 3-3. Contents of a SUMTAPE Record

Real *4 Variables

<u>Array Number</u>	<u>Description</u>
•• 1	YYMMDD of 10-minute interval
2	Start time of 10-minute interval in MSEC
• 3	Contains a 1 (Frequency channel 0)
4	Number of non-zero points of this frequency in the 10-minute interval
5	2% MIN: 2% of the points are below the value of $10 * \log T_A$ stored here
6	2% MAX: 2% of the points are above this value of $10 * \log T_A$
7	MODE: most frequently found value of $10 * \log T_A$
8	MEDIAN. 50% of the points are above (or below) this value of $10 * \log T_A$
9	$100 * \log (\sum T_i)$: linear sum, except for T_i above 2% MAX or below 2% MIN
10	$100 * \log (\sum T_i^2)$ (except those beyond 2% limits)
• 11	Contains a 2 (Frequency channel 1)
12	Number of non-zero points of this frequency
⋮	
⋮	(16 channels × 8 words each, + 2 words = 130)
⋮	
130	$100 * \log (\sum T_i^2)$ for Frequency Channel 15

ORBIT
ATTITUDE

2.4.1 Contents of the O/A Tape

Time Block

1. Julian date, ephemeris time: YYDDD
 2. Time in seconds past January 1, 1950, ephemeris time
 3. Year
 4. Month
 5. Day
 6. Hour
 7. Minutes
 8. Seconds
- } of Gregorian calendar date
9. Time from launch in seconds
 10. ET - UTC, in seconds
 11. ΔT (Time difference between Orbit and Attitude calculations)
 12. Status switch
 - 0 = both Orbit and Attitude data present
 - 1 = Orbit data only
 - 2 = Attitude data only
 13. Spare

Heliocentric Block

14. x
 15. y
 16. z
- } Position coordinates of Helios in A. U.
17. U_x
 18. U_y
 19. U_z
- } Velocity coordinates of Helios in A. U./DAY
- } Mean ecliptic and equinox of 1950 July 1, 0 hours.
- 20 - 25. Same as above, for Mercury
 - 26 - 31. Same as above, for Venus
 - 32 - 37. Same as above, for Earth
 - 38 - 43. Same as above, for Mars

Heliocentric Block (cont'd)

- | | | | |
|---------|---|---|--|
| 44 -49. | Same as above, for Jupiter | } | Mean ecliptic and equinox
of 1950, July 1, 0 hours. |
| 50 -55. | Same as above, for Moon | | |
| 56. | Ecliptic longitude, counted from Mean Equinox of | } | Helios |
| 57. | Ecliptic longitude, counted from Earth-Sun line of | | |
| 58. | Ecliptic latitude of | | |
| 59. | Distance in A. U. of Sun and | | |
| 60 -63. | Same as above, for Mercury | | |
| 64 -67. | Same as above, for Venus | | |
| 68 -71. | Same as above, for Earth | | |
| 72 -75. | Same as above, for Mars | | |
| 76 -79. | Same as above, for Jupiter | | |
| 80 -83. | Same as above, for Moon | | |
| 84. | Radial velocity | } | of Helios in A. U./DAY |
| 85. | Normal velocity | | |
| 86. | Heliographic longitude of Helios, counted from the Ascending Node | | |
| 87. | Heliographic latitude of Helios | | |
| | Number of rotations of the Sun, since launch, | | |
| 88. | referred to the Earth | } | at 16° heliographic latitude |
| 89. | referred to Helios | | |

Geocentric Block

- | | | | | | |
|---------|--------------------------------|---|--------|---|--|
| 90. | Right Ascension of | } | Helios | } | True Earth
equator and
equinox of date |
| 91. | Declination of | | | | |
| 92. | Distance in A. U. of Earth and | | | | |
| 93 -95. | Same as above, for the Moon | | | | |
| 96 -98. | Same as above, for the Sun | | | | |

- 99. Radial velocity of } Helios in A. U./day
 - 100. Normal velocity of }
 - 101. x } Position of Helios in A. U
 - 102. y }
 - 103. z }
 - 104. U_x } Velocity of Helios in A. U./day
 - 105. U_y }
 - 106. U_z }
 - 107-112. Same as above, for the Sun
 - 113. Solar ecliptic latitude of Helios
 - 114. Solar ecliptic longitude of Helios
 - 115. x } Solar Magnetospheric Coordinates
 - 116. y } of Helios
 - 117. z }
- Mean ecliptic and
equinox of 1950
July 1, 0.0 hours

Distances Block

- 118. Helios - Mercury
 - 119. Helios - Venus
 - 120. Helios - Earth
 - 121. Helios - Mars
 - 122. Helios - Jupiter
 - 123. Helios - Moon
 - 124. Helios - Moon Orbit
- } in A. U.

Angles Block

- 125. Earth - Helios - Sun
- 126. Helios - Sun - Earth
- 127. Sun - Earth - Helios
- 128. Helios - Earth - Moon
- 129. Ecliptic Plane - (Earth - Helios) Line
- 130. Right Ascension of Orbit Pole
- 131. Declination of Orbit Pole

} in degrees

Attitude Block

- 132. Flag for Blackout
- 133. Solar Aspect Angle
- 134. 3-Sigma Value of the Solar Aspect Angle
- 135. Pitch Angle
- 136. 3-Sigma Value of the Pitch Angle
- 137. Angle Between Z-Axis and Orbit-Plane
- 138. Mercury Aspect Angle (Angle between Z-Axis and Helios - Mercury Line)
- 139. Venus Aspect Angle
- 140. Mean Spin Rate
- 141. Ecliptic Longitude of S/C - Spin Axis
- 142. Ecliptic Longitude of S/C - Spin Axis, counted from Earth - Sun Line
- 143. Ecliptic Latitude of S/C Spin Axis

- | | | |
|-------|--|--|
| 144.) | } First Row (A_{11} A_{12} A_{13}) of the | } Matrix from S/C
Spin Axis - Sunline
Coordinates to
Heliographic Coordinates |
| 145.) | | |
| 146.) | | |
| 147.) | } Second Row (A_{21} A_{22} A_{23}) of the | |
| 148.) | | |
| 149.) | | |
| 150.) | } Third Row (A_{31} A_{32} A_{33}) of the | |
| 151.) | | |
| 152.) | | |
| 153.) | } First Row (A_{11} A_{12} A_{13}) of the | } Matrix from S/C Spin
Axis - Sunline
Coordinates to Solar
Ecliptic Coordinates |
| 154.) | | |
| 155.) | | |
| 156.) | } Second Row (A_{21} A_{22} A_{23}) of the | |
| 157.) | | |
| 158.) | | |
| 159.) | } Third Row (A_{31} A_{32} A_{33}) of the | |
| 160.) | | |
| 161.) | | |
| 162. | Spare | |

HELIOS

ORBIT ATTITUDE TAPE

EACH RECORD CONSISTS OF A 1
DIMENSIONAL ARRAY OF 162 REAL * 4
WORDS.

THE FOLLOWING JCL WAS USED (GSFC 360-91)

DD UNIT=6250, LABEL=(,SL), DCB=(RECFM=FB,
LRECL=648, BLKSIZE=25920, DEN=4), DSN=HELIOA

SUMMARY TAPE

EACH RECORD CONSISTS OF A 1
DIMENSIONAL ARRAY OF 130 REAL * 4
WORDS.

THE FOLLOWING JCL WAS USED

DD UNIT = 6250, LABEL = (,SL), DCB = (RECFM = FB,
LRECL = 520, BLKSIZE = 31720, DEN = 4), DSN = SUMTPE

March 26, 1979

TO: 601/Director, National Space Science Data Center
FROM: 692/Interplanetary Physics Branch/R. Weber
SUBJECT: HELIOS Experiment Data

We are delivering herewith data from the radio astronomy experiments on HELIOS-1 and -2. Included are experiment 5C daily and monthly data plots on microfilm, and summary tapes containing 10-minute averages. The period from launch through October 31, 1977, is covered for each spacecraft. Because of spacecraft problems HELIOS-1 data were not processed routinely after April 30, 1976. In addition, we are providing orbit/attitude tapes for each spacecraft.

The microfilms contain plots of T_{cal} versus time for each observing frequency. T_{cal} is proportional to observed noise intensity; there is no absolute calibration available. Each point is a 1-minute average for the daily plot and 10-minute average for the monthly plot.

The attached sheets describe the contents of the summary and orbit/attitude tapes. All HELIOS experiments were described in the German journal Raumfahrtforschung, 19, 5, 1975, which we provided previously to the data center.



Richard R. Weber

Attachments:
As stated

cc: 690/R. G. Stone
} 692/K. W. Ogilvie

X-693-74-332

**THE RADIO ASTRONOMY EXPERIMENT
ON HELIOS A AND B**

74-097A-06
76-003A-06

RICHARD R. WEBER

NOVEMBER 1974



**— GODDARD SPACE FLIGHT CENTER —
GREENBELT, MARYLAND**

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Greenbelt, Maryland 20771**

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**"This paper presents the views of the author(s), and does not necessarily
reflect the views of the Goddard Space Flight Center, or NASA."**

THE RADIO ASTRONOMY EXPERIMENT

ON HELIOS A AND B

Richard R. Weber
Radio Astronomy Branch
Laboratory for Extraterrestrial Physics
Goddard Space Flight Center
Greenbelt, Maryland

November 1974

1

2

3

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ABSTRACT

HELIOS is a cooperative space project undertaken by the United States and West Germany. The HELIOS A and B solar probes will be launched between 1974 and 1976 into solar orbits. The perihelion for HELIOS will be about 0.3 astronomical unit (AU).

Goddard Space Flight Center has a radio astronomy experiment on HELIOS, identified as Experiment 5C. A frequency range of 26.5 to 3000 kHz is covered with a dual 16 channel radiometer and a 30 m electric dipole antenna.

POST-LAUNCH ADDENDUM

Helios A was successfully launched on December 10, 1974. The launch vehicle and most spacecraft systems performed nominally. The GSFC radiometer is working well. However all the electric field experiments are experiencing interference arising from two problems. First, one of the two booms forming the dipole did not deploy properly and is shorted to spacecraft ground. This short has caused RFI levels of 3-30 dB above expected levels. A second problem is unexpected interference from the high gain telemetry antenna. This adds about 60 dB of RFI at 27.5 kHz decreasing with increasing frequency so that above 200 kHz it adds no additional RFI. Because of this problem the spacecraft telemetry is being sent via the medium gain antenna when possible, supported by unprecedented coverage by 64m and 100m ground based antennas.

1. INTRODUCTION

HELIOS will be launched into an ecliptic orbit with a perihelion of 0.3 AU and aphelion of 1 AU. The orbital period is about 6 months. The spacecraft will spin at 1 Hz with the spin axis perpendicular to the ecliptic and will have a 30 m electric dipole antenna in the ecliptic plane. The modulated data observed with the spinning antenna will permit a determination of the intensity, direction and angular size of radiation sources. Figures 1 and 2 show HELIOS and its orbit.

In conjunction with direction-finding from spin modulation, simultaneous observations by HELIOS and other spacecraft are planned in order to determine the position and directivity of sources in the solar system via time-of-flight comparisons.

2. PHYSICAL ASPECTS OF THE OBSERVATIONS

Radio astronomy experiments conducted in space, beyond the plasmopause, have extended the observations of solar radio bursts from 10 MHz down to near 10 kHz. These observations have shown that type III (fast-drift) traveling disturbances occur in large numbers over this frequency range. According to present understanding of the process responsible for type III emission, a packet of superthermal electrons, ejected for example during a solar flare, travels out through the corona and interplanetary space along magnetic field lines. These "exciter" electrons produce Cerenkov waves, which in part are converted into electromagnetic radiation at twice the local plasma frequency. This radiation thereby provides a measure of the local plasma density. As the exciter moves outward to regions of

lower density the radiation occurs at progressively lower frequencies and later times. The difference in emission times for two frequencies is then equal to the time for the exciter to pass between the two coronal levels, and allows a determination of the velocity of the exciter. Average emission frequencies are 280 kHz at 0.3 AU and 55 kHz at 1 AU.

The rise time of a burst can be related to the length of the exciter and the size of the emission region. As the exciter moves outward its dimensions grow due to its dispersion of velocities. The increase in rise time at lower frequencies provides a measure of this dispersion. The intensity of the burst yields information on the number of particles in the exciter and the volume of the interacting region. The decay time of the burst is longer than the rise time and has been related to various damping processes in the solar wind. The smoothness of the burst at a given frequency gives some indication of coronal inhomogeneities. A small emission region with large scale scatterers can produce scintillations during a burst.

Observations already conducted in space (RAE-1, IMP-6) have revealed a surprisingly large number of type III solar bursts during the years of maximum solar activity. They arise not only as individual bursts associated with large flares, but also as storms of bursts observed during the entire transit of an active region across the disk of the sun. These storms, composed of thousands of drifting bursts and continuum, are well correlated with active regions on the sun. During one year of hectometer wavelength observations by RAE-1,

more than 10^5 storm type III bursts have been observed in addition to over 10^3 individual or complex groups of type III events.

Analysis of these data has:

- 1) found that the exciter electrons have energies of 5 to 200 keV
- 2) established an average density scale out past 1 AU
- 3) provided an estimate of solar wind bulk speed at distances of 0.4 AU
- 4) shown the existence of magnetic loop structure extending out to 30 solar radii, and
- 5) shown the occurrence of long-lasting streams of superthermal electrons arising in active regions on the sun and moving outward through interplanetary space along open field lines.

It is anticipated that HELIOS will observe not only solar bursts, but also radiation from some of the planets. Earth and Jupiter have been observed at low frequencies from spacecraft near Earth. It is possible that the characteristics of the Earth will look more like those of Jupiter when the observations are made from a great distance. Mercury may be detected when HELIOS is relatively close.

Observations of solar radio sources from a spinning spacecraft such as HELIOS display a modulation pattern which allows a determination of source direction and size to be made. When this is done over a range of frequencies from a few MHz to tens of kHz, the path of a solar exciter as it travels out from the sun to 1 A.U. is outlined by the resulting radio radiation very much as the droplets or bubbles in

a cloud or bubblechamber describe the path of charged particles. Since the exciter is constrained to move along the interplanetary magnetic field which has a direction set by the solar wind, the radio observations of the exciter paths lead to determination of gross structure in the solar wind.

Another powerful method to be employed with HELIOS is time-of-flight measurements of radiation received by two or more separated spacecraft. The data to be used are from HELIOS A and B and RAE-2. Observations from two spacecraft can be correlated on the ground to find the difference in received time. This time difference will define a hyperboloid on which the source is located. Spin modulation and other means will then locate the source on the surface. Both time-of-flight and spin modulation measurements will be applicable to solar bursts and planetary radiation.

The HELIOS radio experiment is very well suited to these tasks. The good sampling rate and sixteen observing frequencies will permit detailed observations to be made over almost the entire path of the burst out to 1 A.U. Moreover, when the spacecraft is near the sun, valuable data on the directivity of the bursts and the size of the emission region will be obtained. Important information about propagation conditions - absorption, scattering, and refraction - should result from observations of radio emission regions at progressively shorter distances.

In addition to solar bursts, there are other phenomena which will yield significant information. Observations of enhanced radio noise

near the local plasma frequency lead to a measure of the plasma density in the vicinity of the spacecraft. As HELIOS moves in its orbit, a measure of the bulk density made in this manner will complement other measurements. Changes in local plasma frequency with time will yield information on solar wind inhomogeneities.

Other spacecraft observations have indicated large amounts of radio noise taking place in processes within the earth's magnetosphere and tail regions. HELIOS, with its direction-finding capability and large dynamic range, should give much information about these effects, especially if they are related to solar phenomena occurring at earlier times.

3. DESCRIPTION OF THE EXPERIMENT

The radio astronomy experiment consists of two extendible 15 m antenna booms forming an electric dipole, two high-impedance preamplifiers located at the root of the booms, and a dual 16 channel radiometer.

Figure 3 is a block diagram of system. The preamplifiers contain gain switching for three 30-db dynamic ranges covering approximately 2 μ v to 60 mv. The preamplifier outputs are combined in a transformer balun located in the main radiometer box. The balun secondary winding feeds both sides of the dual radiometer. Following the balun a low pass filter attenuates frequencies above 3 MHz. A mixer combines the incoming signal with the output of one of the 16 programmed crystal-controlled oscillators. The crystal filter has a 10 kHz bandwidth centered on the 21.4 MHz intermediate frequency (IF). After the IF

amplification the signal is detected and passes through a logarithmic amplifier having an output slope of about 6 db/volt and an output time constant of 8 ms. This logarithmic amplifier also has an output which is compared with preset range switching limits; when the output exceeds the limits the preamplifier gain is changed to the next range.

Each half of the redundant radiometer system operates at the following frequencies:

FREQ	kHz	FREQ	kHz
0	26.5	8	340
1	50	9	445
2	65	10	585
3	85	11	765
4	115	12	1010
5	150	13	1320
6	195	14	2280
7	255	15	3000

Figures 4 and 5 are examples of the radiometer calibration curves produced in a thermal vacuum chamber. In addition to these calibration data, an on-board noise source is used to calibrate the experiment periodically in order to check its continuing satisfactory operation.

A data processing unit (DPU) supplies power and programming signals to the radiometer. It accepts the radiometer analog output of 0-5.08 volts and converts it to seven bit words. It also accepts the two radiometer range bits. These data are processed by the DPU for transfer to the telemetry system.

3A. FREQUENCY SEQUENCING

Data are generated at sixteen observing frequencies by radiometer A or B in any of four commanded frequency sequencing modes.

The four frequency sequences are:

- Mode A $f_0, f_8, f_1, f_9, f_2, f_{10}, \dots, f_7, f_{15}, f_0, f_8, \text{etc}$
staying on each frequency for 16 samples (one-half spin)
- Mode B Same as 1) but always on one commanded pair of f_i, f_{i+8}
- Mode C Single frequency operation at any commanded frequency.
- Mode D Staircase $f_0, f_1, f_2, \dots, f_{15}$ staying on each frequency for 2
of 32 sectors.

In all cases data are spin synchronous and are divided into 32 sectors.
Each data word contains 7 bits of analog data and 2 bits for the
dynamic range. Data are always collected for one complete spin.

3B. COMMANDS

The commands for Experiment 5C are:

IDENTIFICATION	S/C COMMANDS
Reset	050
Mode Bit 2	327
Mode Bit 0	133
Mode Bit 1	244
Freq. Bit 0	071
Freq. Bit 1	306
Freq. Bit 2	112
Freq. Bit 3	265
Radiometer A	175
Radiometer B	202
Calibrate	154

COMMAND FUNCTION

Reset - puts all mode and frequency bits in the zero state. This
will provide operation in Mode A which steps through the
radiometer frequencies in pairs, 0-8, 1-9, 2-10, ..., 7-15.

Mode Bits 0,1,2 - pick frequency sequencing Mode A,B,C or D

according to the table on page 11

Frequency Bits 0,1,2,3 - pick frequency for use in Mode B or D,

according to the table on page 11

Radiometer A - activates radiometer A

Radiometer B - activates radiometer B

Calibrate - switches the preamps from the antenna to an internal noise source which steps through 4 levels.

3C. HOUSEKEEPING DATA

Housekeeping data for Experiment 5C consist of three voltage monitors (+6,-6 and +12), an experiment calibration flag and a ground reference. These data are contained in the DPU engineering data block along with some engineering data for Experiment 5A and the DPU itself. The data block is read out sequentially in the spacecraft telemetry locations B008 and B009. There are also temperature monitors in each preamplifier and the main radiometer. These monitors are read out as spacecraft engineering data.

3D. EXPERIMENT DATA FRAME

One Experiment Data Frame (EDF) contains 320 bits for all bit rates and for Format 1,2,3, and 5. The 320 bits are generated during one rotation (32 sectors) of data. Data read-in is synchronized to the spacecraft spin. Collection of data starts on an arbitrary even sector and is stored in one of two alternating buffers. Telemetry reads out the data of one of the buffers while data begins to accumulate in the other buffer. Since the data generation rate exceeds the telemetry rate some sectors are skipped between the groups of 32 sectors. Pages 13-16 describe the EDF.

Frequency Mode A cycles through all frequencies in 8 EDF's (320 words). Frequency Modes B,C and D go through one complete cycle in 1 EDF. The Mode tables on pages 17 and 18 give the relationships between spacecraft Bit Mode (BM), Format Mode (FM), Data Mode (DM) and the Experiment 5C EDF.

3E. INTERNAL CALIBRATION CYCLE

The internal calibration cycle lasts for 32 EDF's (4 pages). During calibration the Exp 5C preamps are switched off the antennas and are connected to an internal noise source which steps through four levels, beginning with the highest level and ending with the lowest level. Each level lasts 8 EDF's (1 page). The preamplifiers then are reconnected to the antenna.

This calibration cycle occurs automatically each 2^{16} seconds (about once per 18 hours) and can be commanded at any time. It is not expected that the command will be used much during normal spacecraft operation.

EXP 5C FREQUENCY COMMANDS

S/C COMMAND

<u>FREQ</u>	<u>265</u>	<u>112</u>	<u>306</u>	<u>071</u>
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

EXP 5C FREQUENCY SWITCHING MODES

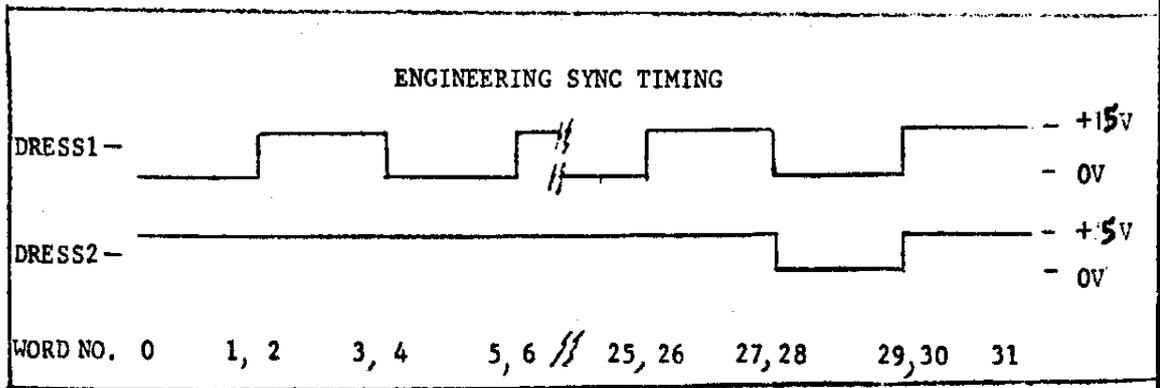
S/C COMMANDS

<u>MODE</u>	<u>327</u>	<u>244</u>	<u>133</u>
A	0	0	0
A	1	X	X
B	0	0	1
C	0	1	1
D	0	1	0

X means irrelevant

DPU DATA BLOCK
Engineering

Word No.	Bit Number							
	0	1	2	3	4	5	6	7
0 B8	5CGND	5CGND	5CGND	5CGND	5CGND	5CGND	5CGND	5CGND
1 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
2 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
3 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
4 B8	10VBIT7	10VBIT6	10VBIT5	10VBIT4	10VBIT3	10VBIT2	10VBIT1	10VBITO
5 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
6 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
7 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
8 B8	15VBIT7	15VBIT6	15VBIT5	15VBIT4	15VBIT3	15VBIT2	15VBIT1	15VBITO
9 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
10 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
11 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
12 B8	15VBIT7	15VBIT6	15VBIT5	15VBIT4	15VBIT3	15VBIT2	15VBIT1	15VBITO
13 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
14 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
15 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
16 B8	5VBIT7	5VBIT6	5VBIT5	5VBIT4	5VBIT3	5VBIT2	5VBIT1	5VBITO
17 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
18 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
19 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
20 B8	6VBIT7	6VBIT6	6VBIT5	6VBIT4	6VBIT3	6VBIT2	6VBIT1	6VBITO
21 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
22 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
23 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
24 B8	6VBIT7	6VBIT6	6VBIT5	6VBIT4	6VBIT3	6VBIT2	6VBIT1	6VBITO
25 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
26 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
27 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
28 B8	12VBIT7	12VBIT6	12VBIT5	12VBIT4	12VBIT3	12VBIT2	12VBIT1	12VBITO
29 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.
30 B8	5CFREQ4	5CFREQ3	5CFREQ2	5CFREQ1	5CM3	5CM2	5CM1	5CRA
31 B9	5CCAL	SABIT3	SABIT2	SABIT1	SABITO	GAIN1	GAINO	Sh. Inh.



Description of Experiment Data Frame

R Radiometer Range - R2XX = LSB

RAD Radiometer Voltage - RADXX0 = LSB

5CN Noise Cal Level - 5 CN1 = LSB (not binary coded)

5CFRQ Starting frequency E5C - 5CFRQ1 = LSB. RAD01 is sampled at that frequency.

5CRA Radiometer indicator - Rad. A = "1"

CFRQ Commanded frequency E5C (has no meaning, if frequency is cycling). Backup for command verification.(CFRQ1=LSB)

5CLAST Format flag E5C - set only in FM 3, because the DPU is sampling the data from E5C in this mode at first.
In all other modes vice versa.

SECT Sector counter - 32 stages - SECT0 = LSB

ESYNC Engineering counter readout - alternating between all zeros and all ones. Not used.

5ABL Commutation counter for Experiment 5A - 5ABL1 = LSB

XX Number of sample (32 total for E5C)

5CM Mode Experiment 5C. The following coding is used:

<u>S/C Command</u>	<u>327</u>	<u>244</u>	<u>133</u>	
Mode	Bit 2	Bit 1	Bit 0	- Designation Command Status
	5CM3	5CM2	5CM1	- Designation Exp. Data Block

The mode bits are set by ground command. They are also sampled and transferred in the command status word in the engineering frame.

Diagram of Experiment Data Block

Formats 1,2,3,5 Expr. 5C

Word No.	Bit Number							
	0	1	2	3	4	5	6	7
0	5CN4	5CN3	5CN2	5CN1	5CFRQ4	5CFRQ3	5CFRQ2	5CFRQ1
1	5CRA	CFRQ4	CFRQ3	CFRQ2	CFRQ1	5CM3	5CM2	5CM1
2	5CLAST	SECT4	SECT3	SECT2	SECT1	SECT0	5ABL2	5ABL1
3	ESYNC	ESYNC	ESYNC	ESYNC	ESYNC	ESYNC	ESYNC	ESYNC
4	R101	R201	RAD016	RAD015	RAD014	RAD013	RAD012	RAD011
5	RAD010	R102	R202	RAD026	RAD025	RAD024	RAD023	RAD022
6	RAD021	RAD020	R103	R203	RAD036	RAD035	RAD034	RAD033
7	RAD032	RAD031	RAD020	R104	R204	RAD046	RAD045	RAD044
8	RAD043	RAD042	RAD041	RAD040	R105	R205	RAD056	RAD055
9	RAD054	RAD053	RAD052	ROAD51	RAD050	R106	R206	RAD066
10	RAD065	RAD064	RAD063	RAD062	RAD061	RAD060	R107	R207
11	RAD076	RAD075	RAD074	RAD073	RAD072	RAD071	RAD070	R108
12	R208	RAD086	RAD085	RAD084	RAD083	RAD082	RAD081	RAD080
13	R109	R209	RAD096	RAD095	RAD094	RAD093	RAD092	RAD091
14	RAD090	R110	R210	RAD106	RAD105	RAD104	RAD103	RAD102
15	RAD101	RAD100	R111	R211	RAD116	RAD115	RAD114	RAD113
16	RAD112	RAD111	RAD110	R112	R212	RAD126	RAD125	RAD124
17	RAD123	RAD122	RAD121	RAD120	R113	R213	RAD136	RAD135
18	RAD134	RAD133	RAD132	RAD131	RAD130	R114	R214	RAD146
19	RAD145	RAD144	RAD143	RAD142	RAD141	RAD140	R115	R215
20	RAD156	RAD155	RAD154	RAD153	RAD152	RAD151	RAD150	R116
21	R216	RAD166	RAD165	RAD164	RAD163	RAD162	RAD161	RAD160
22	R117	R217	RAD176	RAD175	RAD174	RAD173	RAD172	RAD171
23	RAD170	R118	R218	RAD186	RAD185	RAD184	RAD183	RAD182
24	RAD181	RAD180	R119	R219	RAD196	RAD195	RAD194	RAD193
25	RAD192	RAD191	RAD190	R120	R220	RAD206	RAD205	RAD204
26	RAD203	RAD202	RAD201	RAD200	R121	R221	RAD216	RAD215
27	RAD214	RAD213	RAD212	RAD211	RAD210	R122	R222	RAD226
28	RAD225	RAD224	RAD223	RAD222	RAD221	RAD220	R123	R223
29	RAD236	RAD235	RAD234	RAD233	RAD232	RAD231	RAD230	R124
30	R224	RAD246	RAD245	RAD244	RAD243	RAD242	RAD241	RAD240
31	R125	R225	RAD256	RAD255	RAD254	RAD253	RAD252	RAD251
32	RAD250	R126	R226	RAD266	RAD265	RAD264	RAD263	RAD262
33	RAD261	RAD260	R127	R227	RAD276	RAD275	RAD274	RAD273
34	RAD272	RAD271	RAD270	R128	R228	RAD286	RAD285	RAD284
35	RAD283	RAD282	RAD281	RAD280	R129	R229	RAD296	RAD295
36	RAD294	RAD293	RAD292	RAD291	RAD290	R130	R230	RAD306
37	RAD305	RAD304	RAD303	RAD302	RAD301	RAD300	R131	R231
38	RAD316	RAD315	RAD314	RAD313	RAD312	RAD311	RAD310	R132
39	R232	RAD326	RAD325	RAD324	RAD323	RAD322	RAD321	RAD320

Position of EDF within the Telemetry Main Frames

DPU DATA READOUT

Expr. 5C - Science

DPU Data Block Word No.	Format 1		Format 2		Format 3		Format 5	
	Word Number	Frame Number	Word Number	Frame Number	Word Number	Frame Number	Word Number	Frame Number
0	76		60		86		21	
1	77		61	Frame Numbers	87	Frame Numbers	22	
2	78		62	Which	88	Which	23	
3	79	Frame Numbers	63	Mod.8	97	Mod.8	24	
4	80	Which	64	Are=0	98	Are=0	93	Frame Numbers
5	81	Mod.2	60		86		94	which
6	82	Are=0	61	Frame Numbers	87	Frame Numbers	95	Mod.4
7	83		62	Which	88	Which	96	Are=0
8	84		63	Mod.8	97	Mod.8	132	
9	85		64	Are=1	98	Are=1	133	
10	86		60		86		21	
11	87		61	Frame Numbers	87	Frame Numbers	27	
12	88		62	Which	88	Which	23	Frame Numbers
13	89		63	Mod.8	97	Mod.8	24	Which
14	90		64	Are=2	98	Are=2	93	Mod.4
15	91		60		86		94	Are=1
16	92		61	Frame Numbers	87	Frame Numbers	95	
17	93		62	Which	88	Which	96	
18	94		63	Mod.8	97	Mod.8	132	
19	95		64	Are=3	98	Are=3	133	

Example: All words in this block will be in frames 0,2,4,6,8, etc.

DPU DATA READOUT
Exp. 5C - Science

DPU Data Block Word No.	Format 1		Format 2		Format 3		Format 5	
	Word Number	Frame Number						
20	76		60		86		21	
21	77		61	Frame Numbers	87	Frame Numbers	22	
22	78		62	Which	88	Which	23	
23	79	Frame Numbers	63	Mod.8	97	Mod.8	24	
24	80	Which	64	Are=4	98	Are=4	93	Frame Numbers
25	81	Mod.2	60		86		94	Which
26	82	Are=1	61	Frame Numbers	87	Frame Numbers	95	Mod.4
27	83		62	Which	88	Which	96	Are=2
28	84		63	Mod.8	97	Mod.8	132	
29	85		64	Are=5	98	Are=5	133	
30	86		60		86		21	
31	87		61	Frame Numbers	87	Frame Numbers	22	
32	88		62	Which	87	Which	23	
33	89		63	Mod.8	97	Mod.8	24	Frame Numbers
34	90		64	Are=6	98	Are=6	93	Which
35	91		60		86		94	Mod.4
36	92		61	Frame Numbers	87	Frame Numbers	95	Are=3
37	93		62	Which	88	Which	96	
38	94		63	Mod.8	97	Mod.8	132	
39	95		64	Are=7	98	Are=7	133	

Example: All words in this block will be in frame 1, 3, 5, 7, 9, etc.

EXP. 5C - MODE TABLE - MODE A

1	2	3	4	5	6	7	8	9	10	11
Exp. Mode	BM	FM	DM	EDFs per EDMF	Words per EDF	Words per EDMF	Words per Frame	Frames per EDMF	Time per EDMF	Spare
A	4096 2048	5 5	any	8	40	320	10	32	9.0s 18.0s	
A	2048 1024 512	1 1 1	any	8	40	320	20	16	9.0s 18.0s 36.0s	
A	512 256 128 64	2 2 2	any	8	40	320	5	64	2.4m 4.8m 9.6m 19.2m	
A	64 32 16 8	3 3 3 3	any	8	40	320	5	64	19.2m 38.4m 76.8m 153.6m	

Remarks: 1 EDMF = Experiment Data Main Frame = one complete cycle of the experiment, i.e. each science channel must be sampled once at least.

Word - means 8 bit telemetry word
 Frame - means science telemetry frame
 Col. 10 - s = seconds, m = minutes
 FM 6 does not contain data from E5c.

EXP. 5C - MODE TABLE - MODE B,C,D

1	2	3	4	5	6	7	8	9	10	11
Exp. Mode	BM	FM	DM	EDFs per EDMF	Words per EDF	Words per EDMF	Words per Frame	Frames per EDMF	Time per EDMF	Spare
B,C,D	4096	5	any	1	40	40	10	4	1,1s 2,3s	
	2048	5								
B,C,D	2048	1	any	1	40	40	20	2	1,1s 2,3s 4,5s	
	1024	1								
	512	1								
B,C,D	512	2	any	1	40	40	5	8	18,0s 36,0s 72,0s 2,4m	
	256	2								
	128	2								
	64	2								
B,C,D	64	3	any	1	40	40	5	8	2,4m 4,8m 4,6m 19,2m	
	32	3								
	16	3								
	8	3								

1

2

3

4

5

6

7



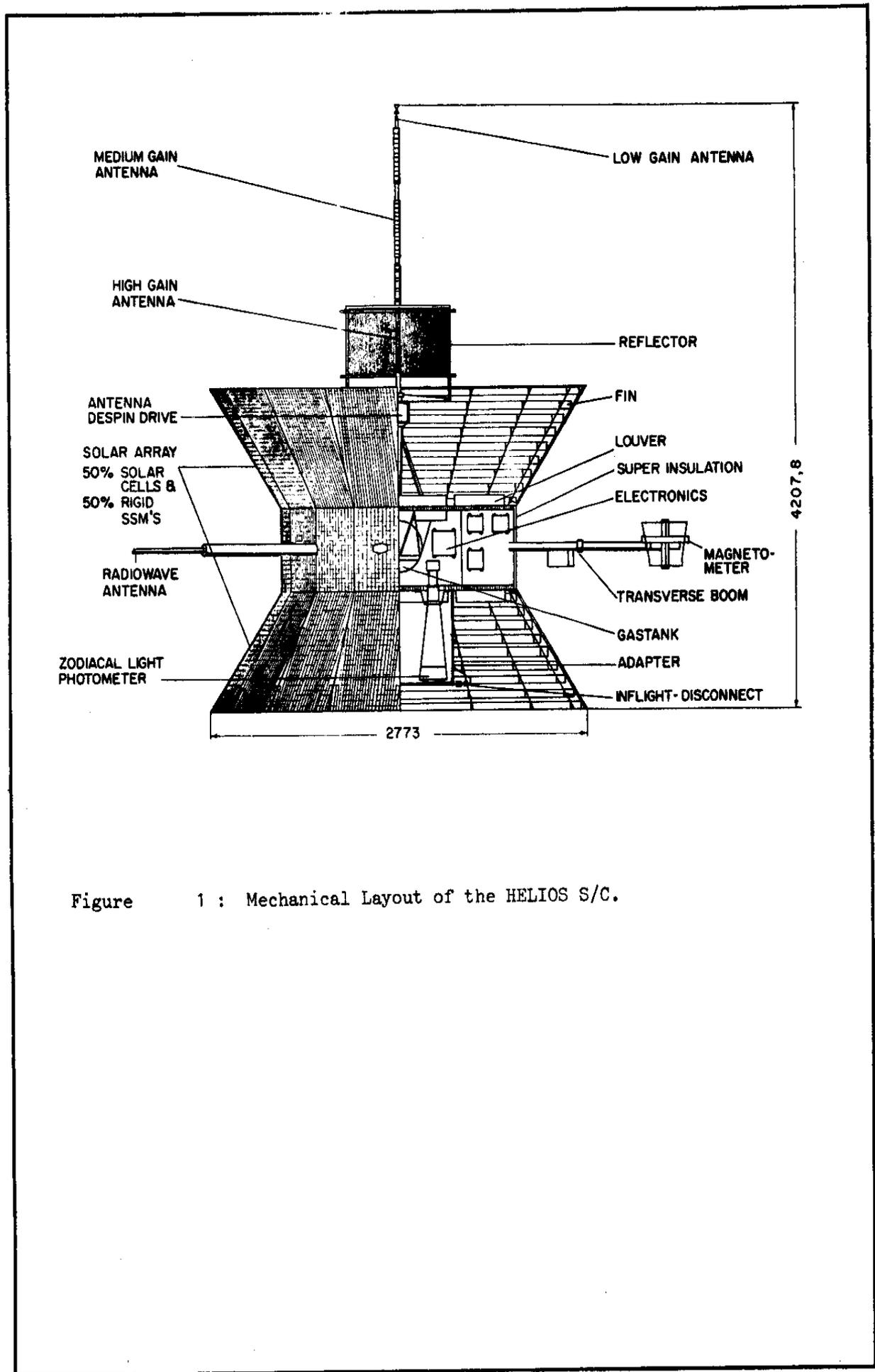
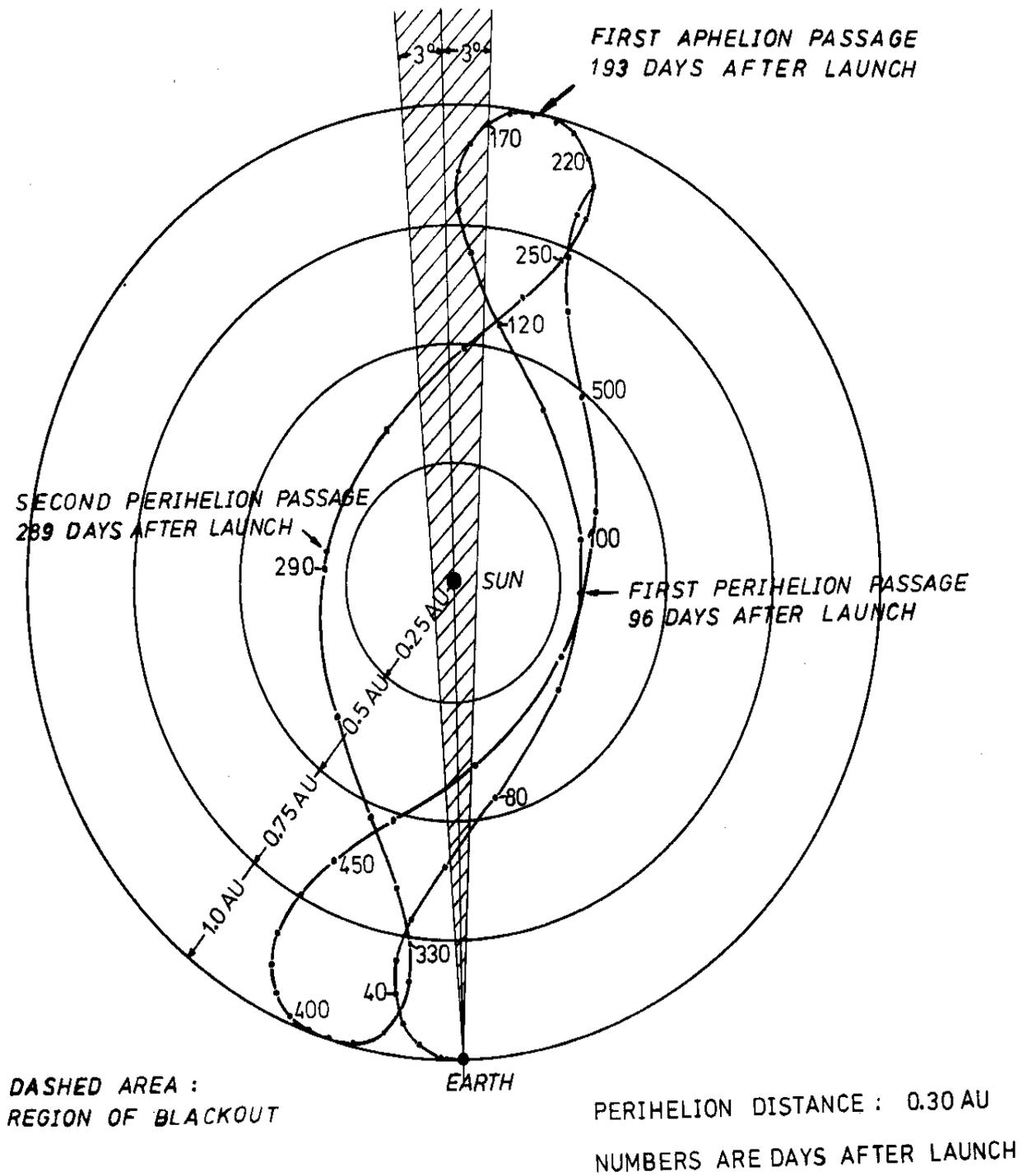
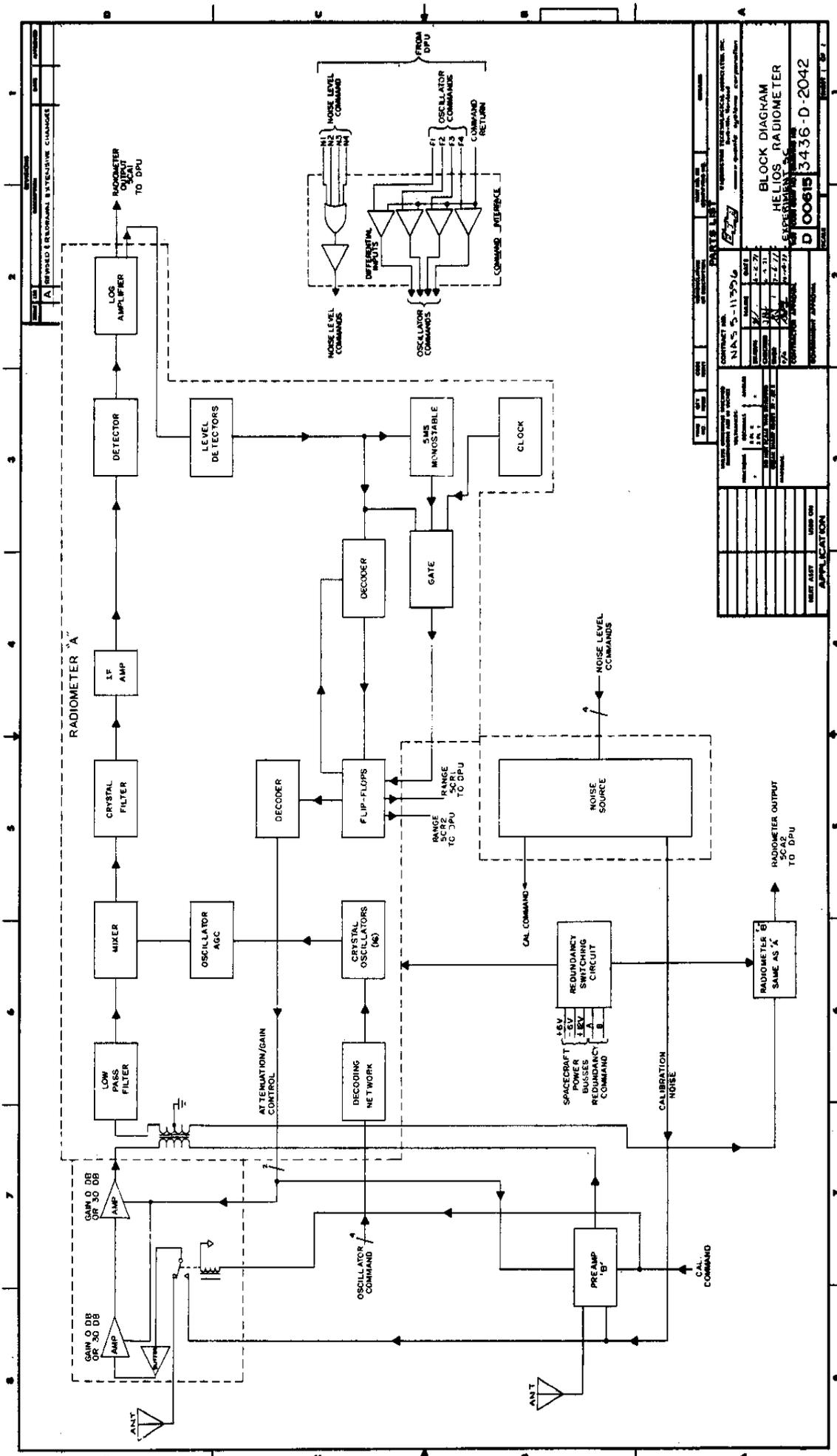


Figure 1 : Mechanical Layout of the HELIOS S/C.



HELIOS ORBIT FOR FIXED EARTH-SUN LINE

Fig. 2. Ecliptic Plane View of HELIOS in a Heliocentric Rotating Coordinate System with Earth-Sun line fixed



DATE LIST CONTRACT NO. N.A.S. 5-11506 HELIOS RADIOMETER EXPERIMENTAL D 00615 3436-D-2042	
APPROVED & REVISIONS DATE BY REVISION	APPLICATION DATE BY REVISION

Fig. 3

1

2

3

4

5

6

7

